Non-prompt J/ψ measurement with the PHENIX VTX detector at RHIC

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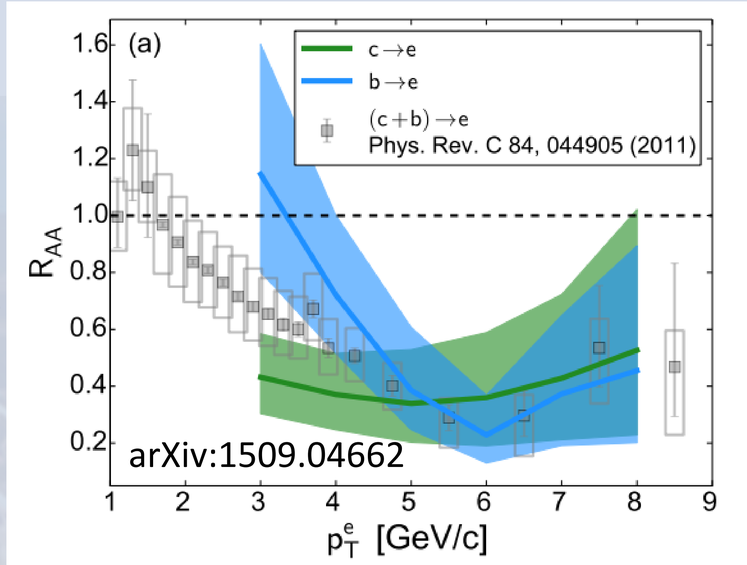
Introduction

Heavy quark (bottom and charm) is a clean probe to study the property of QGP.

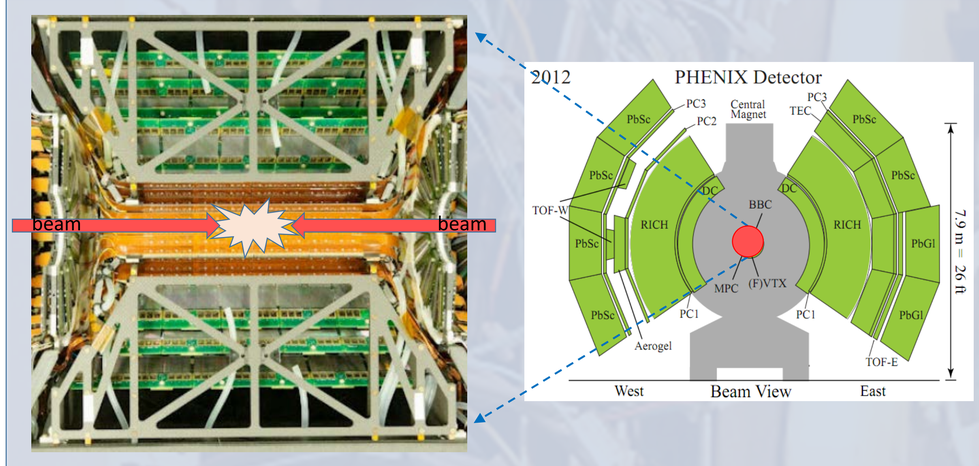
- Bottom and charm separation is imperative to understand heavy quark suppression in QGP.
  - New result of separated bottom and charm yield
    - D. MCGLINCHEY(talk 9/28 space 2B, poster)
    - H. Asano (poster)
    - K. Nagashima (poster)
  - The measurement shows that bottom is less suppressed than charm
    - Similar with recent LHC measurement



Non-prompt J/ψ as a probe

- B → J/ψ + X → $e^+ + e^-$
- This is a direct measurement of B production.
  - Bottom & charm separation is not necessary, which introduces additional systematic uncertainty.
- It is challenging to extract the signal
  - Branching ratio (B → J/ψ) is small (~1%)
  - Main background is prompt J/ψ that comes from the collision vertex

Silicon Vertex Tracker (VTX)

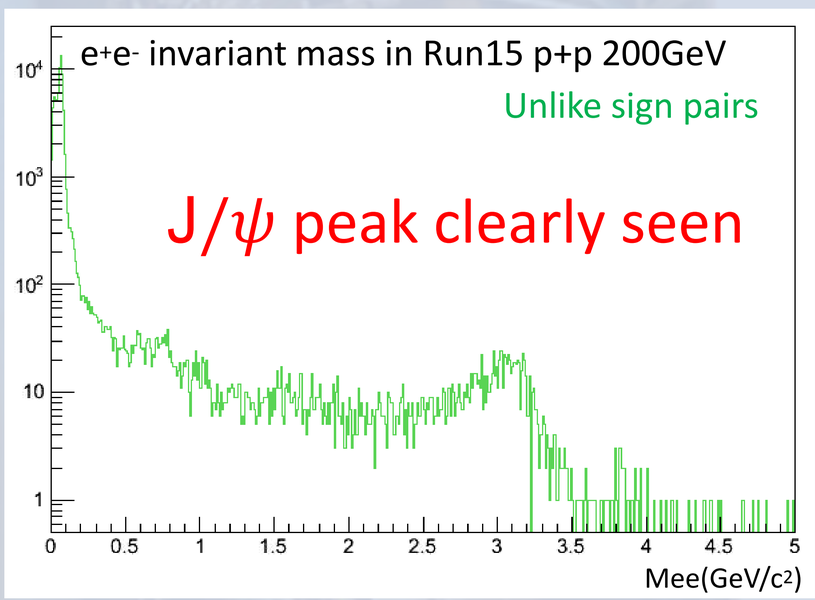


- Structure : 4 Si layers (2 pixel & 2 stripixel)
- Wide acceptance: |ϕ|~2π, |y|<1.2
- Capabilities:
  - Precise tracking around collision vertex
  - Collision vertex determination
- DCA resolution is ~60μm (pT>4GeV/c) for electron measurement

Data analysis

Analysis method

1. J/ψ → e^+e^-
   - e^+e^- pairs are measured by the central arm + VTX
2. 2nd vertex reconstruction
   - The position of closest approach for e^+e^- pairs in 2D plane (X-Y).



Improve the J/ψ signals

- Conversion veto cut
  - remove electrons from Dalitz decays & conversions for reduction of the combinatorial BG.
- Z-Distance of e+e- at 2nd vertex position
  - Z-distance should be zero for true pairs but non-zero for fake pairs

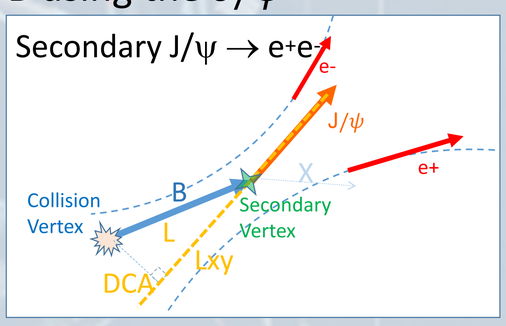
Non-prompt J/ψ extraction

Pseudo proper time (x)

the decay length ($c\tau$) of B using the J/ψ

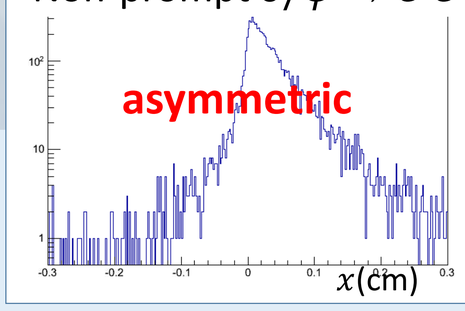
$$x = \frac{Lxy \cdot M_{J/\psi}}{p_{T(J/\psi)}} \sim c\tau(B)$$

L : B decay length
Lxy: projection of L to J/ψ
p_T : J/ψ pT
M : J/ψ mass

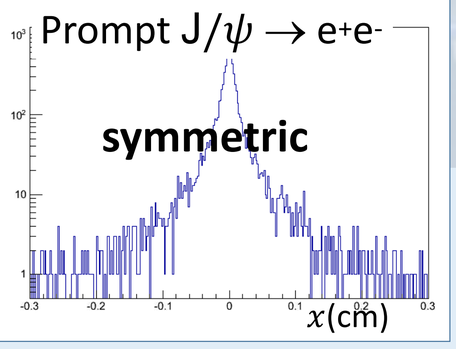


Pseudo proper time distribution in simulation (PYTHIA + GEANT)

Non-prompt J/ψ → e^+e^-



Prompt J/ψ → e^+e^-



Non-prompt J/ψ can be extracted using shape difference of pseudo proper time

Single electron DCA can improve non-prompt J/ψ

Summary & Outlook

- Non-prompt J/ψ extraction is feasible based on simulation
- Data analysis is in progress for both p+p and Au+Au 200GeV
  - VTX improves the J/ψ measurement and reduces combinatorial BG.
  - Single electron DCA can enrich the non-prompt J/ψ signal
  - Large amount of p+p and Au+Au data was recorded in run2014 & 2015
    - Statistics is 10 times larger than run11 Au+Au
      - 10 B min. bias Au+Au collisions
      - VTX performance was improved

- Expected yield of non-prompt J/ψ
  - Number of J/ψ is 10000 @ 10 B minimum bias data in Au+Au 200GeV
  - J/ψ yield in p+p 200GeV
    - Non-prompt J/ψ : $\sigma_{b\to J/\psi\to e^+e^-}$ = 1.2nb (PRL.103.082002 PHENIX)
    - Prompt J/ψ : $\sigma_{J/\psi\to e^+e^-}$ = 45 nb (PRL. 98, 232002 PHENIX)
    - Production ratio : 2.6% in p+p, 5.2% in Au+Au
      - 50% of suppression factor is used for Prompt J/ψ yield in Au+Au
  - The expected non-prompt J/ψ is 100~200 in Au+Au 200GeV